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DEVELOPMENT OF TEACHING MATERIALS USINGREALISTIC MATHEMATICS EDUCATION APPROACHES IN IMPROVING THE CAPACITY OF MATHEMATIC COMMUNICATION OF PGSD STUDENTS

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Abstract

This research is motivated by the lack of mathematical communication skills of PGSD IKIP Siliwangi students. The purpose of this study is to improve the mathematical communication skills of PGSD IKIP Siliwangi students through the Realistic Mathematics Education (RME) approach with the help of teaching aids. The specific target to be achieved in this research is the formation of teaching materials that are appropriate, practical, efficient, and effective, and can also develop the productivity of PGSD IKIP Siliwangi students. This research uses a quantitative approach and uses a quasi-experimental method. The population in this study was PGSD IKIP Siliwangi students, while the sample consisted of 70 students who were divided into 35 students in class A1 of 2017 as an experimental group and 35 students in class A2 in 2017 as a control group. The instrument used consisted of written tests regarding mathematical communication skills and the practice of making teaching aids, observations and interviews. The results showed that there was an increase in mathematical communication skills of PGSD students using the RME approach better than those using ordinary learning.

Kata Kunci: Mathematical Communication, Realistic Mathematics Education, Teaching Aids.

1. INTRODUCTION

Mathematics is a science learned from elementary school through college. According to (Rofiah, 2010), mathematics plays a role as a symbolic language that enables the realization of accurate and accurate communication. Mathematical communication is very important to be taught because according to Huang and Normandy (Rohmah, 2013), the use of both oral and written communication by teachers and students when learning mathematics is very important to build mathematical thinking.

But the reality on the ground, based on the experience of researchers. The ability of students to express mathematical ideas and ideas both oral and written is still low. Students still have difficulty in presenting mathematical problems into ideas, ideas and mathematical language.

The application of the Realistic Mathematics Education (RME) approach is one solution so that mathematical communication skills in PGSD students can be increased. The RME approach is an approach that emphasizes mathematics taught meaningfully by linking mathematics with real-life that is realistic in real life. This is why the RME approach is very suitable to be taught to elementary students because at this stage students are at the stage of concrete operations. At this stage, students can understand operations logically with the help of concrete objects. The use of concrete objects such as teaching aids made from used materials can make it easier for students to understand what is being taught by their teacher, moreover, it can improve students' mathematical communication skills. This is in accordance with the opinion of (Suwardi et al., 2014), ages 7 to 12 years included in the phase of concrete operations, where the child's ability to think logically has developed with the condition that the object that is the source of logical thinking is present concretely, then in teaching mathematics should try to use teaching aids where the abstract can be concrete.

Learning is inseparable from teaching materials. Effective, applicable and interesting teaching materials for learning mathematics can help students improve their mathematical abilities. According to (Ramdani, 2012), "Teaching material is a very important part of an overall learning process". In addition, with teaching materials, students will be directed and understand what is being learned. This is what underlies researchers to take the title "Preparation of Teaching Materials using Realistic Mathematics Education Approach to Improve PGSD Mathematical Communication Capabilities on the Environment".

Mathematical Communication Skills

Communication can be interpreted as the delivery of messages between two or more people so that the intended message can be understood. In general, communication is the process of delivering a message or news from the sender of the message to the recipient of the message both verbally and in writing for a particular purpose. Whereas mathematical communication is the ability of a person to express mathematical ideas either verbally or in writing in the form of concepts, formulas, or strategies for solving a problem. According to TIM (Bernard, 2015), states that communication is the sending and receiving of messages between two or more people so that the intended message is conveyed. So in learning mathematics, when a concept of mathematical information is given by a teacher to students or students are actively involved in working on mathematics, thinking about their ideas, writing, or talking with and listening to other students, in sharing ideas, then when it is happening transformation of mathematical information from the communicator to the communicant, or mathematics communication is taking place.

According to Baroody (Rosita, 2014), mathematics learning should help students communicate their mathematical ideas through representation, listening, reading, discussing, and writing. Furthermore, according to Pugalee (Pradhini, 2016), so students can be trained in their mathematical communication skills, in learning students need to be accustomed to giving arguments or any answers given by others so that what is being learned becomes more meaningful to him.

According to NCTM (Fajriani, 2016), mathematical communication is the ability of students to express mathematical ideas both verbally and in writing. While Greene's and Schulman (Heryan, 2018), said that mathematical communication is: (1) central power for students in formulating mathematical concepts and strategies, (2) capital for students' success in approaching and solving in exploration and mathematical investigations, (3) a place for students in communicating with friends to obtain information, share thoughts and discoveries, brainstorm, assess and sharpen ideas to convince others. According to (Fatimah, 2012), "The ability of students to work on questions in the form of symbols is less accompanied by the ability to communicate mathematical ideas contained therein. Students are not accustomed to pouring thoughts in oral and written form.

Each learning event will occur interconnected or communicate with each other both between lecturers and students and with fellow students. Mathematics learning is also inseparable from communication. Communication in learning mathematics is very important, this was stated by Baroody (Sumarmo, 2012), there are two important reasons why learning mathematics focuses on communication,

1. Mathematics is an essential language that is not only as a means of thinking, finding a formula, solving a problem, or just concluding, but mathematics also has unlimited value to express various ideas clearly, thoroughly and right,
2. Mathematics and learning mathematics is the heart of human activities, for example in mathematics learning interactions between teachers and students, between students and students, between mathematics learning materials and students are important factors in advancing student potential.

Students' communication skills can be improved in various ways, including by conducting group discussions in class. In group discussions, students are grouped into small groups with heterogeneous abilities. In the group, students get the opportunity to express their ideas and opinions about problems given by the lecturer and can exchange ideas between friends in one group. This can develop and improve students' mathematical communication skills.

To see the mathematical communication skills possessed by students can be seen from the indicators of communication skills in mathematics learning. Indicators of mathematical communication skills according to Sumarmo (Ruqoyyah, 2018),

1. Connecting real objects, pictures, and diagrams into mathematical ideas,
2. Explain ideas, situations, and mathematical relations verbally and in writing with real objects, pictures, graphics, and algebra,
3. Expressing everyday events in language or mathematical symbols,
4. Listening, discussing, and writing about mathematics,
5. Reading with an understanding of a mathematical presentation,
6. Constructing conjectures, compiling arguments, formulating definitions and generalizations,
7. Reveal a description or paragraph of mathematics in their own language.

Indicators of mathematical communication skills used in this study are stating daily events with the language of mathematics; explain mathematical ideas and situations verbally and in writing with real objects.

Realistic Mathematics Education Approach

In accordance with Freudental's view ((Husna et al., 2013) states that mathematics is a human activity that emphasizes the activities of students to find, find, build their own knowledge needed so that learning becomes student-centered, namely the Realistic Mathematical Approach (PMR). According to Zulkarnain (Wijaya, 2012), RME

emphasizes the teaching of meaningful mathematics by linking it to real-life realities that are realistic. The RME approach presents contextual problems that describe situations in the real world so students can imagine them.

According to Treffers and Gravemeijer (Chotimah, 2014), RME has the characteristics of steps,

1. Use of Context
2. Vertical Instruments
3. Student Contributions
4. Interactive Activities
5. Linkage Topics

Furthermore, in realistic learning, there are five mathematical steps to solve real-world problems in PISA problems (Wijaya, 2012)

1. Starting with real-world problems,
2. Identifying concepts relevant to the problem according to mathematical concepts,
3. Gradually leave the real world situation through the process of formulating assumptions, generalizing, and formalizing,
4. Solving mathematical problems (this process occurs in the world of mathematics),
5. Re-translating mathematical solutions into real situations, including identifying the limitations of the solution.

According to Suwarsono (Hadi, 2009), the advantages of RME learning,

1. Provide a clear understanding of the relationship between mathematics with everyday life and about the usefulness of mathematics in general for humans,
2. Mathematics is a field of study that can be constructed and developed on its own
3. How to solve a problem or problem does not have to be single, and need not be the same as other people,
4. Learning the mathematics of the learning process is the main thing and to learn the mathematics of people must go through the process and find their own mathematical concepts with the help of the teacher,
5. Combining the strengths of various other learning approaches that are also considered superior, namely between the problem-solving approach, the constructivism approach, and the environment-based learning approach.

Teaching Material uses a Realistic Mathematics Education Approach

Teaching material is one of the keys to the success of learning. Teaching material in learning is one component that must be present because teaching material is a component that must be studied, examined, studied and made into material that will be mastered by students and at the same time can provide guidelines for learning (Hernawan et al., 2012).

Furthermore, Hernawan et al. (2012)argued that when learning will take place, a professional educator should understand the characteristics of the contents of the learning message to be conveyed, so that it is not wrong in choosing learning strategies, learning interactions, classroom management, selection learning materials and learning media, and evaluation tools that will be used. From the opinion above, it can be understood that to provide information in learning, it is necessary to prepare good teaching materials to meet learning criteria that can be understood and not boring students, one of which is teaching materials related to the daily context of students so that their integration will be in accordance with the way of learning. so the learning process and learning outcomes will be optimal.

At the time of learning, students are asked to make mathematics teaching aids. Mathematical teaching aids are made from items that are no longer used. Mathematical teaching aids are made adapted to the material to be studied. Then the teaching aids that have been made, demonstrated and tried to solve everyday problems and demonstrated using the Realistic Mathematics Education approach.

Elementary Mathematics Learning Subjects

Elementary mathematics learning courses are one of the subjects that discuss mathematical materials in primary schools assisted with teaching aids where students not only gain mathematical knowledge but gain experience in forming personality as a teacher, develop pedagogical skills, strengthen competence in the field of mathematics in Elementary school and develop student skills in making teaching aids. The material discussed in this course is for example integers, KPK (Multiple Largest Alliance) and FPB (Largest Alliance Factor), flat area, building volume, and so on.

2. METHOD

The method in this study is a quasi-experimental method. In quasi-experimental subjects are not randomly grouped, but researchers accept the state of makeshift subjects. Ruseffendi (2010)states that for Quasi-Experimental designs with non-equivalent designs pretest and posttest control group design. Both groups both received pretest and posttest, but only the experimental group was given treatment. Learning in the experimental class uses the Realistic Mathematics Education approach through the preparation of teaching materials while learning in the control class uses ordinary learning. The design of this study by (Sugiyono, 2013)is as follows.

Table 1. Design Research: Nonrandomized Pretest-Posttest Control Group Design

Class	Pretest	Treatment	Posttest
Experiment	O	X_1	O
Control	O	X_2	O

O : Pretest or posttest mathematical communication skills

X_1 : Learning with a Realistic Mathematics Education approach

X_2 : Ordinary learning

The population in this study were all PGSD students in semester 2 of 2017, both regular and non-regular classes. The samples in this study are PGSD semester 2 students of 2017, A1 class with 35 people as the experimental class and A2 class with 35 people as the control class. This research was conducted at the Siliwangi Institute of Teacher Training and Education (IKIP). The instruments used in this study were mathematical communication instruments, observation, and interviews. After the instrument is completed, the instrument is validated to an expert and validated to the field so that the instrument is truly validated. Then the instrument is used in the pretest and posttest stages which are then processed and analyzed using the help of SPPs 20 application.

The research procedure consists of three stages, namely the preparation phase, the implementation phase, and the completion stage. The stages of the preparation of the activities undertaken are analyzing the results of research that have previously been carried out regarding mathematical communication, analyzing the development of students in the preparation of teaching materials, compiling teaching materials which use a Realistic Mathematics Education approach, arranging instruments, validating, and testing instruments.

At the implementation stage, the activities carried out are the implementation of the pretest, carrying out learning in the experimental class using teaching materials using the Realistic Mathematics Education approach and in thecontrol class using ordinary learning, and the implementation of the posttest. In the final stages of research, the activities carried out are collecting research data, processing and analyzing research results, and preparing research reports and publication of research results.

3. RESULT AND DISCUSSION

This research was conducted during 8 meetings consisting of 1 pretest meeting, 6 learning treatments and 1 posttest. Quantitative data in the form of pretest and posttest data. The data is used to analyze the quality of students' mathematical communication skills. Quantitative data processing using the help of Microsoft Excel 2010 software and SPSS 20. To complete the results of the analysis, a comprehensive description of the performance of students during learning takes place and during the pretest-posttest.Descriptive recapitulation of overall research data can be seen in the form of the following table:

Table2. Recapitulation of Student Mathematical Communication Skill Values

Ability	Statistic	RME Approach (N=35)			Ordinary Learning (N=35)		
		Pretest	Postest	N-Gain	Pretest	Postest	N-Gain
Communication Mathematical SMI 4	$\bar{x}$	2,74	3,51	0,51	1,35	1,98	0,24
	%	68,50	87,75	51	33,75	49,50	24
	Sd	0,47	0,08	0,36	0,64	0,73	0,27

From Table 2., it can be seen that the average score of the experimental class pretest and the control class communication skills are not classified as high. This shows that the initial abilities of the two classes are the same, in this case, they are equally unaware of elementary mathematics learning materials. While the posttest average scores of the two classes are quite different for their communication skills. This shows that the mathematical communication skills of the experimental class students are better than the control class. However, to see whether the difference is significant or not, a statistical test is performed.

a. Analysis of Mathematical Communication Skills Based on Learning Approaches

1) Pretest Data Analysis Mathematical Communication Skills

Before the treatment of both classes is given, first a pretest is conducted. The aim is to determine the initial mathematical communication skills of the control class and experimental class students so that
the initial abilities of both classes can be outlined as equal or not. For statistical analysis of pretest data using SPSS 20 software.

Based on Table 2. above shows that the average initial mathematical communication ability of control class students is 1,35. While the average initial ability of mathematical communication experimental class students is 2,74. It is generally seen that the average initial ability score of the experimental class students is higher than the control class even though both are not classified as high. To find out whether there is a significant difference or not between the experimental class and the control class a statistical test is performed as follows:

a) Normality Test

The normality test used in this study is the Kolmogorov-Smirnov test. By using a significance level of 0,05 and the test criteria are if the sig value. > 0,05 then the data is normally distributed. The following is a table of normality test results using SPSS 20 software,

Table 3. Pretest Data Normality Test Mathematical Communication Ability

Class	*Statistic*	Df	Sig.
Control	,128	35	,158
Experiment	,179	35	,006

Based on Table 3. The significance value obtained from the control class is 0,158> 0,05 and for the experimental class, the significance value is 0,006 <0,05. In accordance with the test criteria, the control class samples were normally distributed, while the experimental class samples were not normally distributed. Because one of the data comes from a population that is not normally distributed, then to test the significance of the difference between the two averages using a non-parametric test, the Mann-Whitney test.

b) Test Difference of Two Averages

Based on the results of the normality test, it was obtained that one of the

classes came from a sample that was not normally distributed so that the two-test difference was average for the pretest data of communication skills using the Mann-Whitney test. In this study the Mann-Whitney test used is Monte Carlo by taking the following hypotheses:

H_0: $m_1 = m_2$(there is no significant difference in the initial ability of students' mathematical communication between those learning using the RME approach through teaching materials and those using ordinary learning)

H_1: $m_1 \neq m_2$ (there is a significant difference in the initial ability of students' mathematical communication between those learning using the RME approach through teaching materials and those using ordinary learning)

Test criteria: if the value of sig. > 0,05 then H_0 is accepted.Here is a table of test results using SPSS 20 software,

Tabel 4. Difference Test Two Average Pretest Data Mathematical Communication Capabilities

Class	Sig.	Interpretation
Control	0,000	H_0 accepted
Experiment		

Based on Table 4., the value of 0,000 was taken from Monte Carlo Sig. (2-tailed) in the processing table attached to the attachment, it appears that in the table above the value of sig. 0,000 <0,05. Following the testing criteria, H_0 is rejected, meaning that there are differences in the initial ability of students' mathematical communication between those learning using the RME approach and those using ordinary learning.

2) Posttest Data Analysis Mathematical Communication Capabilities

The results of the posttest data analysis were used to see the achievement of the communication skills of the experimental class and the control class. Based on Table 1., the average mathematical communication ability of control class students after being given normal learning is 1,98 or around 49,50%, while the average mathematical communication skills of experimental class students after being given learning with the RME approach is 3,51 or around 87,75%. It can be seen that in general the average posttest score of the experimental class students is greater than that of the control class, and is of different qualification, that is, moderate and high. To find out whether the achievement of mathematical communication skills of students in the experimental class and the control class differed significantly or not, the following statistical tests were performed:

1) Normality Test

Similar to the normality of pretest data testing, posttest data testing in this study also uses the Kolmogorov-Smirnov test. The test criteria are if the value of sig. > 0,05 then the data is normally distributed. Here is a table of test results using SPSS 20 software,

Table 5. Posttest Data Normality Test Mathematical Communication Capabilities

Class	*Statistic*	Df	Sig.
Control	0,172	35	0,010
Experiment	0,323	35	0,000

Based on Table 5. obtained the significance value of the control class 0,001 <0,05 and the experimental class 0,047 <0,050 means that the two data are not normally distributed, then to test the significance of the difference between the two averages using a non-parametric test, the Mann-Whitney test.

2) Difference Test of Two Averages

Based on the results of the normality test, the next step is to test the difference in two averages for the posttest data using a non-parametric test, the Mann-Whitney test. With the following hypothesis:

H_0: $m_1 = m_2$(there is no significant difference in the achievement of students' mathematical communication abilities between those learning using the RME approach through teaching materials and those using ordinary learning)

H_1: $m_1 > m_2$ (significantly the achievement of mathematical communication skills of students whose learning using the RME approach through teaching materials is better than those using ordinary learning).

Because the difference between the two posttest tests is a one-sided hypothesis test, the test criteria are accepted H_0. The Mann-Whitney test used in this study is Monte Carlo. Based on the test results using SPSS 20 software attached to the attachment, the following results are obtained:

Table 6. Difference Test Two Average Posttest Data Mathematical Communication Capabilities

Class	Sig.	Interpretation
Control	0,000	H_0 rejected
Experiment		

Based on Table 6, it appears that the significance value is 0,000. Because of the one-party test, what was seen was Monte Carlo Sig. (1-tailed). This value is less than 0,05 so H_0 is rejected. So, the posttest score of the experimental class students was significantly better than the control class. This means that after learning is done, the achievement of mathematical communication skills of students whose learning uses the RME approach through teaching materials is better than those using ordinary learning.

3) Analysis of N-Gain Data Communication Skills

N-gain data is used to see anincrease instudents' mathematical communication skills. Based on Table 1., it shows that the average increase in mathematical communication skills of control class students after being given regular learning is 0.24. While the average increase in mathematical communication skills of experimental class students after being given learning with the RME approach is 0.51. To find out whether the improvement in mathematical communication skills of students in the experimental class and the control class differed significantly or not, a statistical test was performed as follows:

1) Normality Test

The gain data normality test in this study also uses the Kolmogorov-Smirnov test. The test criteria are if the value of sig. > 0.05 then the data is normally distributed. Here is a table of test results using SPSS 20 software,

Table 7. N-Gain Data Normality Test Mathematical Communication Capabilities

Class	*Statistic*	Df	Sig.
Control	0,191	35	0,002
Experiment	0,287	35	0,000

Based on Table 7. obtained the significance value of the control class 0,002 <0,05 and the significance value of the experimental class 0.000 <0.05 means that the two data are not normally distributed.

2) Difference Test of Two Averages

Based on the results of the normality test it was found that the two classes
came from samples that were not normally distributed so that the two different tests for the average N-Gain data on communication skills using the Mann-Whitney test. In this study the Mann-Whitney test used is Monte Carlo by taking the following hypotheses:

H_0: $m_1 \leq m_2$ (significantly increased students' mathematical communication skills between those whose learning uses the RME approach through teaching materials is smaller or equal to those using normal learning)

H_1: $m_1 > m_2$ (significantly improved mathematical communication skills of students whose learning using the RME approach through teaching materials is better than those using ordinary learning).

Because the different test of the two n-gain averages is a one-sided hypothesis test, the test criterion is accepted H_0 if the Monte Carlo Sig value. (1-tailed)> 0,05 and rejected if Monte Carlo Sig. (1-tailed) <0,05. Based on the test results using SPSS 20 software attached to the attachment, the following results are obtained:

Table 8. Difference Test Two Average N-Gain Data for Mathematical Communication Capabilities

Class	Sig.	Interpretation
Control	0,000	H_0 rejected
Experiment		

Based on Table 8., it appears that the significance value is 0,000. Because of the one-party test, what was seen was Monte Carlo Sig. (1-tailed). This value is less than 0,05 so H_0 is rejected. So, the improvement of experimental class students is better than the control class. This means that after learning has been done, increasing the mathematical communication skills of students whose learning uses the RME approach through teaching materials is better than those using ordinary learning.

Discussion of the results of this study is based on data that has been previously analyzed and field findings regarding mathematical communication skills, as well as the RME approach.At the beginning of the study, students were on classes that use RME learning and classes that use regular learning are given mathematical communication skills pretest. The result is the average value of students in the experimental class and the control class differs, with the average pretest of the experimental class and the control class not quite high. Although there is a difference between the initial mathematical communication skills of the experimental class students and the control class. But this shows that the students in the experimental class and the control class do not know much or know the material to be provided so that the basic abilities are the same.

At the next meeting, theexperimental class was treated with the RME approach through teaching materials. Students in the experimental class were instructed to make mathematics teaching aids in groups. Mathematical teaching aids are made adapted to the material to be studied in teaching materials. The materials used to make props come from used goods. After the students finished making mathematics props, the students then demonstrated the mathematics props using the RME approach through daily problems. At the first meeting the perceived obstacles, students had difficulty in making mathematical teaching aids

and lack of confidence in conveying how to demonstrate mathematical teaching aids by following the questions given. From these findings, improvement is needed, namely by making learning plans more maximized by explaining the steps of making teaching aids in providing information for the learning process. The results of direct interviews with students, learning mathematics using teaching aids is very helpful in understanding the material being taught. And other findings, students become more active, skilled, collaborate in groups, and dare to express opinions.

Meanwhile, the control class was given the usual Learning treatment. The usual learning referred to in this study is mathematics learning is done through the presentation of material in groups. At the first meeting, when one of the groups presented the topic being discussed, many students were less enthusiastic because of the poor delivery of the group presenting. Based on the results of direct interviews conducted this happens because students begin to get bored with the learning process with group presentations, besides the appearance and readiness of the groups that appear to be less attractive because they do not understand the material and are less attractive in the delivery.

At the last meeting of the study, students in the experimental class and the control class were given a posttest to know the student's final ability after obtaining learning. The posttest results showed that the mathematical communication skills of students in the experimental class who obtained the RME learning approach through teaching materials obtained a higher level of achievement compared to the control class who obtained normal learning. The average posttest results of the experimental class students were in the high category while for the control class the average posttest results were in the medium category as well. However, the posttest results of students who use RME learning are greater than classes that use ordinary learning. This shows that the achievement of mathematical communication skills with the RME approach through teaching materials is better than with ordinary learning.

Based on the test results of the significance of the difference in the two average shows that after learning, the achievement of mathematical communication skills in the experimental class that uses the learning approach RME through teaching materials is better than the control class that uses regular learning. This is because when learning with the RME approach students are required to be more active, creative, and critical in modeling problems, finding problem-solving, so that when students are given other problems in the form of mathematical problems, the student is accustomed to dealing with mathematical communication problems.

Likewise, the improvement in students 'mathematical communication skills, after learning to improve students' mathematical communication skills in the experimental class who obtained RME learning was higher than the increase in mathematical communication skills of control class students who used ordinary learning, with criteria classified as moderate for both classes.

These results indicate that students' mathematical communication skills can increase higher by using RME learning which requires active learning, cooperative and group skills, and the courage to express opinions. This is in line with research conducted by Zulkardi(Azhar, 2012)which compares the attitudes of students taught with the RME approach and the conventional approach. The results of this study also showed that students behaved more positively when taught with the RME approach. Also, research conducted by (Murni, 2017)which states that learning with the RME approach can improve critical and creative thinking skills as well as students' mathematical resilience.

4. CONCLUSION

a. Improved mathematical communication skills of PGSD students who use the RME approach through teaching materials are better than those using ordinary learning.
b. PGSD students in learning by using the RME Approach become active, skilled, cooperate in groups, and dare to express opinions.

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